SIEMENS

MOBILETT Plus/ -E/ -M

SP

Maintenance Instructions

System

MOBILETT Plus/ -E/ -M

Including DHHS requirements

The protocol SPR8-215.832.04.03.02 is required for these instructions

© Siemens AG 2002
The reproduction, transmission or use of this document or its contents is not permitted without express written authority. Offenders will be liable for damages. All rights, including rights created by patent grant or registration of a utility model or design, are reserved.

Print No.: SPR8-215.831.04.03.02
Replaces: SPR8-215.831.04.02.02

English
Doc. Gen. Date: 07.05

Document revision level

The document corresponds to the version/revision level effective at the time of system delivery. Revisions to hardcopy documentation are not automatically distributed.

Please contact your local Siemens office to order current revision levels.

Disclaimer

The installation and service of equipment described herein is to be performed by qualified personnel who are employed by Siemens or one of its affiliates or who are otherwise authorized by Siemens or one of its affiliates to provide such services.

Assemblers and other persons who are not employed by or otherwise directly affiliated with or authorized by Siemens or one of its affiliates are directed to contact one of the local offices of Siemens or one of its affiliates before attempting installation or service procedures.

Table of Contents

1 General 5

Check at the beginning of the maintenance session . . . 5
Training. . . . 6
Required documents . . . 7
Required tools, measurement and auxiliary devices . . . 8
Required lubricants. . . . 9
Replacement parts . . . 10
Text emphasis . . . 11
Symbols . . . 12
Safety information and protective measures . . . 13
Protective measures when working on the capacitor bank . . . 14
Service information. . . . 16
Information pertaining to the USA . . . 17
Explanation of abbreviations in the maintenance certificate. . . . 18
Technical Safety Checks (TSC) . . . 19

2 Inspection and maintenance 24

Visual inspection. . . . 24
Damage . . . 24
Mechanical inspection . . . 25
Rear wheels . . . 25
Front wheels . . . 26
Supporting wheels . . . 27
Turn plate (MOBILETT Plus/Plus M only). . . . 28
Brakes. . . . 29
Transport safeguard . . . 30
Handles. . . . 30
Collimator adjustment knobs. . . . 30
Arm system and single tank . . . 31
Mains cable. . . . 32
Arm system mounting . . . 33
Arm cable harness . . . 36
Motor batteries (MOBILETT Plus M only). . . . 37
Service mode . . . 38
Maintenance tests . . . 40
Backup battery G1/D1 . . . 41
Test of kV accuracy . . . 42
Test of mAs accuracy . . . 44
Check for reproducibility . . . 46
Remote exposure switch system (optional) . . . 49
DAP measuring system (optional) . . . 50

Replacing the collimator lamp 51
Checking the luminance 53
Coincidence of radiation and light fields 54
Checking the radiation indicator 56
Checking the manual exposure interrupt 57
Protective conductor measurement 58
Equivalent leakage current measurement. 59
Cleaning the system 60
Checking the kV and mAs displays. 61
Motor drive function (MOBILETT Plus M only) 62

3 _____ Changes to the previous version _____ 63

1 General

1.1 Check at the beginning of the maintenance session

The system condition should be checked via remote service (if available). If error messages appear, the necessary spare parts have to be ordered. If necessary, a new appointment for Preventive Maintenance has to be arranged.

A quick check must be carried out directly at the system. For this, the "Quality Assurance" procedure or similar procedures can be used.

Additionally, check the system logbook for system problems (if available).

The necessary escalation measures have to be initiated after deviations. If necessary, a new appointment for Preventive Maintenance has to be arranged.

1.2 Training

- Due to the type of technology used in this system, service and maintenance work may be performed only by service engineers who have the required training and work authorization for MOBILETT Plus.

1.3 Required documents

• Installation and Start-up	SPR8-215.814...
• Service Instructions	SPR8-215.898...
• Wiring Diagram	SPR8-215.051...
• FDA Form FD2579 (for USA only)	
• Instructions for Use	SPR8-220.201...
• Technical Safety Checks – Protocol *	SP00-000.834.01...

NOTE

The Instructions for Use contain the label locations, tube cooling charts and other information useful for maintenance.

* Within the purview of DIN VDE 0751-1, we recommend documenting the maintenance results both in the maintenance protocol and in the TSC protocol. The protocols should be filled out completely and handed over to the client after maintenance is completed.

1.4 Required tools, measurement and auxiliary devices

NOTE

All tools, measurement and auxiliary devices, with the exception of those marked "* ", are listed in the STC (Service Tools Catalog) along with their specifications.

- Standard service equipment*
- Digital multimeter
- kV measurement device (works with the filter comparison method)
  or storage oscilloscope with ± 2.5 % accuracy
- Storage oscilloscope with ± 2.5 % accuracy
- Protective conductor meter
- Equivalent leakage current meter
- Torque wrench 6-12 Nm
- Torque wrench 20-25 Nm
- Lux meter (only for USA)
- Spring scale for 350 N
- Dose meter (only for USA or if optional 'DAP measuring system' is installed)
- Cable (min. 4 m long; min. 1000 N tensile strength)*
- 2 pieces of wood, approximately 50 x 75 x 500 mm (2.5 x 3 x 20 inches)*
- Calibration tool for 'DAP measuring system', part no. 65 84 978

1.5 Required lubricants

- Viscogen oil

1.6 Replacement parts

• Collimator lamp (every year)	04 48 738
• Backup battery (every 5 years)	31 65 289
• Remote control battery (optional) (every year)	9 volt alkaline battery
For units with cable winder only:	
• Cable winder cpl. (incl. mains cable) (every 4 years)	65 08 746
• Mains cable (every 2 years)	65 00 792
For units without cable winder only:	
• Mains cable (every 2 years)	64 11 438 (in USA) 64 11 388 (in rest of world)

1.7 Text emphasis

⚠DANGER	**DANGER indicates when there is an immediate danger that l e a d s to death or serious physical injury.**
⚠WARNING	**WARNING indicates a risk of danger that m a y l e a d to death or serious physical injury.**
⚠ CAUTION	**CAUTION used with the safety alert symbol indicates a risk of danger that leads to slight or moderate physical injury and/ or damage to property.**
NOTICE	**NOTICE used without the safety alert symbol indicates a risk of danger that if disregarded leads or may lead to a potential situation which may result in an undesirable result or state other than death, physical injury or property damage.**

Fig. 1: Safety Notes

NOTE	**NOTE contains information provided with special emphasis to facilitate proper use of the equipment or proper execution of a procedure, i.e. hints, tips.**

1.8 Symbols

Checks and adjustments that must be performed with radiation ON are identified by the radiation warning symbol.

This symbol means "Dangerous voltage".

This symbol means "Attention, consult the documentation".

U
S
A

Several of the sections in these instructions are for the USA only. These sections are identified with this symbol.

Sections marked with this symbol have been included in the Siemens Training Video (part of the self-study package), which can be ordered through Siemens Customer Service.

This symbol indicates components sensitive to electrostatic discharge (ESD).

1.9 Safety information and protective measures

⚠WARNING

Risk of death, injury or material damage.

Non-compliance can lead to death, injury or material damage.

- **When performing service work and tests adhere to the product-specific safety information in the documents.**
- **When performing service work and tests adhere to the general safety information contained in ARTD Part 2.**
- **Only connect the MOBILETT Plus/Plus E/ Plus M to a mains power supply outlet (receptacle) that corresponds to the installation requirements of VDE 0107 or to country-specific regulations.**
- **Remove or install boards only when the generator is switched OFF. Adhere to the ESD guidelines .**
- **Checks and adjustments performed with radiation ON are identified by the radiation warning symbol . During these types of adjustments, radiation protective clothing must be worn.**
- **Perform the protective conductor test according to ARTD-002.731.17... upon completion of the work and after all covers have been reattached.**

⚠WARNING

When working on the open unit there is a risk of electric shock!

Non-compliance can lead to injury or death.

Observe the following:

- **Never work with the system open if the capacitor is charging or has just been charged.**
- **The capacitor bank may still be charged even if the system is switched OFF and the mains cable is disconnected. There is a risk of life-threatening electric shock.**
- **To avoid danger, refer to the section entitled “Protective measures when working on the capacitor bank”.**

1.10 Protective measures when working on the capacitor bank

NOTE

Comply with the information given in this section before opening the system.

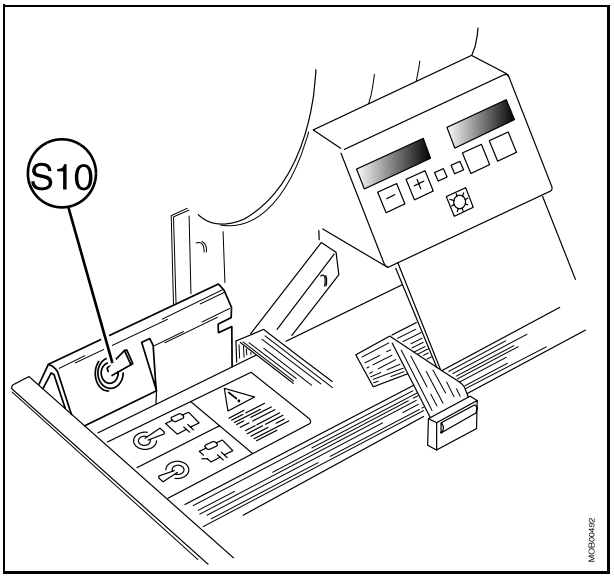

Fig. 2:

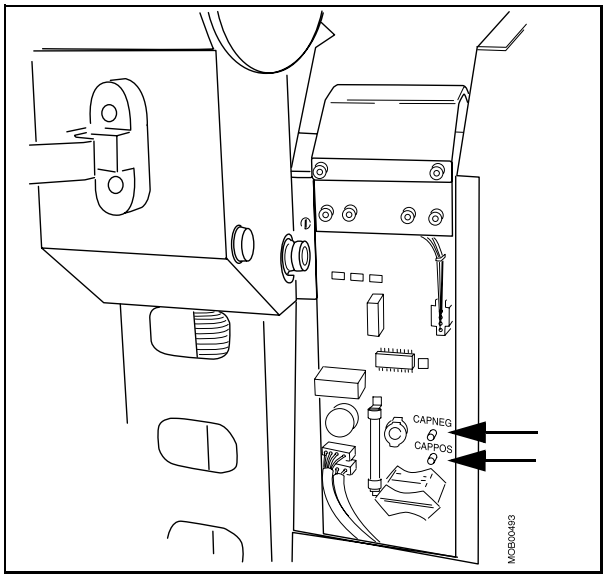

Fig. 3:

⚠ DANGER

When working on the open unit there is a risk of electric shock!

Non-compliance can lead to injury or death.

Observe the following:

- ➪ **Never work with the system open if the capacitor is charging or has just been charged.**
- ➪ **The capacitor bank may still be charged even if the system is switched OFF and the mains cable is disconnected. There is a risk of life-threatening electric shock.**
- ➪ **Consult the information in this chapter.**

- System OFF.
- Disconnect the mains cable.
- Remove the upper system cover.
- Discharge the capacitor bank with S10 (D7) (Fig. 2 / p. 14).
- Wait 5 minutes, then remove the left and right covers and the cover with the cassette compartment.
- Measure the residual voltage at test points CAPPOS and CAPNEG on board D7 (Fig. 3 / p. 14). The measured voltage must be less than 10 V.

⚠WARNING

Risk of electric shock!

Non-compliance can lead to injury or death.

- ➪ **If the voltage measured between CAPPOS and CAPNEG is 0 V, the measurement device could be defective or the wires between the CAPPOS and CAPNEG test points on the capacitor bank could be damaged.**
- ➪ **The capacitors could still be charged.**
- ➪ **In this case, proceed as follows:**

- Make sure that the correct measurement range is set on the measurement device.
- Connect the measurement device to CAPPOS and CAPNEG.
- Switch S10 off. Connect the mains cable and switch the system ON.
- Check whether the voltage increases.
- Switch the system OFF, disconnect the mains cable and switch S10 on.
- Check whether the voltage decreases.

⚠WARNING

If charging/discharging does not function, the capacitor bank must be assumed to be "charged".

This means there is a risk of high voltage.

- ➪ **Use caution when performing measurements at the bus bar of the capacitor bank. Use only the specified measurement devices (350 V DC). If one of the fuses in the capacitor series has blown out, this series must be considered to be fully charged.**

1.11 Service information

Service engineers must complete and sign the maintenance protocol. Repair measures and other service work not contained in the report must be listed separately.

1.12 Information pertaining to the USA

To ensure compliance with the applicable regulations in the ”US Federal Performance Standard”, the system user must ensure that the following maintenance is performed at least once a year. Neither the system manufacturer nor its representatives assume any responsibility in the event of non-compliance with the above requirement.

1.13 Explanation of abbreviations in the maintenance certificate

Abbrev.	Description
SI	Safety Inspection
SIE	Electrical Safety
SIM	Mechanical Safety
PM	Preventive Maintenance
PMP	Periodic Preventive Maintenance
PMA	Preventive Maintenance Adjustments
PMF	Preventive Check of Operating Values/Functions
Q	System Quality, Image Quality
QIQ	Image Quality
QSQ	System Quality Check
SW	Software Maintenance
CSE	Customer Service Engineer
KSK No.	Customer-specific code
IVK	Installed Volume Component
GR	Maintenance Unit

The steps identified by these abbreviations are part of the maintenance certificate and should be checked off upon completion.

1.14 Technical Safety Checks (TSC)

Abbreviation: TSC = Technical Safety Checks

NOTE

- **Within the purview of DIN VDE 0751-1, the operator of medical engineering products has to perform technical safety checks at regular intervals.**
- **The checks listed in these maintenance instructions contain all technical safety checks according to DIN VDE 0751-1 – except for the checks regarding the completeness, presence and legibility of the necessary operator documents.**
- **A separate protocol with print number SP00.000.834.01... is available for each technical safety check.**
- **Within the purview of DIN VDE 0751-1, we recommend documenting the maintenance results both in the maintenance protocol and in the TSC protocol. The protocols should be filled out completely and handed over to the client after maintenance is completed.**
- **In the table below, each technical safety check listed in document SP00.000.834.01... is assigned to the corresponding maintenance work.**

Technical Safety Checks, **Test certificate - check**	**Maintenance instructions - check/** **Comments**
1 Identification data	Please fill in the fields.
2 General checks	n.a.
2.1 Visual inspection: Is there any damage affecting safety?	2.1.1 Damage, checks: SIM Covers SIM Cassette compartment SIM Control and display panel SIM Exposure release cable SIM Single tank generator SIM Collimator
2.2 Are all cables and cable guides firmly attached and in place, without any visible damage?	2.2.10 Mains cable, checks: SIM Cable winder SIM Damage SIM Protective conductor 2.2.12 Arm cable harness, check: SIM Damage

Technical Safety Checks, Test certificate - check	Maintenance instructions - check/ Comments
2.3 Are the accessories being used free of damage?	2.1.1 Damage, check: SIM DAP (optional)
2.4 Are the system's radiation protection devices installed and damage-free? (no radiation protection for the building)	2.15 Checking the radiation indicator, checks: SIE Radiation indicator SIE Audible signal 2.16 Checking the manual exposure interrupt, checks: SIE Message "USE20" SIE 10 short beep signals
2.5 Are the required operator documents complete, present and legible?	The operating instructions must be present. Ask the client for further required operator documents and check if the documents are complete, present and legible.
2.6 Are all warning labels in place and recognizable?	2.1 Visual inspection, check: SIM Labels
2.7 Are the operating symbols, light indicators and button labels OK?	2.5 Maintenance tests, check: SIE Display test 2.20 Checking the kV and mAs displays, checks: SIE Visibility of displays SIE Correct displays
3. Electrical checks	n.a.
3.1 Measurement of the protective conductor resistance	2.17 Protective conductor measurement, check: SIE Measured value
3.2 Measurement of leakage current or equivalent leakage current	n.a.
3.2.1 Leakage current	n.a.
3.2.2 Equivalent leakage current	2.18 Equivalent leakage current measurement, check: SIE Measured value
3.3 Measurement of patient leakage current or equivalent patient leakage current	n.a.
3.3.1 Patient leakage current measurement	n.a.

Technical Safety Checks, Test certificate - check	Maintenance instructions - check/ Comments
3.3.2 Equivalent patient leakage current measurement	n.a.
4. Mechanical checks	n.a.
4.1 Are all wall, ceiling and floor mountings firmly attached, in place, and damage-free?	n.a.
4.2 Are all mechanically movable system parts clean and running smoothly (lubricated, if required)?	2.2.6 Transport safeguard, checks: SIM Damage SIM Locking 2.2.9 Arm system and single tank, checks: SIM Movement of the arm system and the single tank SIM Movement of the single tank fork SIM Single tank movement
4.3 Are the wire cables, chains, belts and spindles free of wear and tear?	2.2.1 Rear wheels, check: SIM Drive belt
4.4 Mobile equipment: Are the wheels, castors and brakes OK?	2.2.1 Rear wheels, checks: SIM Brake lining SIM Secure mounting SIM Ease of movement 2.2.2 Front wheels, checks: SIM Secure mounting SIM Ease of movement 2.2.3 Supporting wheels, checks: SIM Ease of movement SIM Damage 2.2.5 Brakes, checks: SIM Uniformity SIM Braking force SIM Locking
4.5 Is there any unusual noise during operation (e.g. gearing)?	2.2.9 Arm system and single tank, check: SIM Movement of the arm system and the single tank
5. Functional checks	n.a.
5.1 Function of the emergency-stop switch	n.a.

Technical Safety Checks, Test certificate - check	Maintenance instructions - check/ Comments
5.2 Are the warning devices functioning properly?	2.15 Checking the radiation indicator, checks: SIE Radiation indicator SIE Audible signal
5.3. Do all system movements stop properly in their end positions?	n.a.
5.4 Does the collision protection device stop all system movements properly (e.g. collision protection)?	n.a.
5.5. Are all safety distances (wall, floor, ceiling) met or ensured by other appropriate measures (such as light barriers)?	n.a.
5.6. Are the other safety shutdown devices functioning properly (e.g. safety floor plate)?	2.21 Motor drive function, check: SIE Shutdown
5.7 Are the positions of the table and unit reproducible (e.g. zero positions, layer height, etc.)?	n.a.

Technical Safety Checks, Test certificate - check	Maintenance instructions - check/ Comments
6. Product-specific checks	2.2.7 Handles, check: SIM Mounting 2.2.8 Collimator adjustment knobs, check: SIM Mounting 2.2.11 Arm system mounting, check: SIM Screws and lock nuts 2.2.11.1 Adjustment screw, checks: SIM Lock nuts SIM Base mounting 2.2.11.2 Arm connecting piece, check: SIM Screws and nuts 2.2.11.3 Single tank fork, checks: SIM Screw connections on the fork SIM Single tank screw connections 2.10 Remote exposure switch system (optional), check: SIE Function of remote exposure switch system 2.11 DAP measuring system (optional), check: SIE Function of DAP measuring system
7. Test result/evaluation:	Evaluate the long-term trends of the protective conductor resistance and the equivalent leakage current by comparing the current measuring values with those of the preceding technical safety check. A sudden or unexpected increase in the measured values may indicate a safety-relevant defect – even if no limit value is exceeded. Fill in the result of the check. Have the operator, or a person authorized by the operator, sign the TSC protocol. Hand the TSC protocol over to the operator, or a person authorized by the operator.

2 Inspection and maintenance

2.1 Visual inspection

SIM Labels

- Certification labels, labels with the model and serial numbers and a ”WARNING” label are attached to the unit. The label locations are indicated in the Instructions for Use.
- Ensure that all labels are legible and visible.

PMP Customer documentation

- Check that the following documents are filed on site:
  - Instructions for Use
  - User statements and a copy of FDA form FD 2579, completed and signed by the assembler at the time of installation
  - Periodic maintenance records/checks/protocol
  - Assembler reports after major repairs

U
S
A

2.1.1 Damage

Check the following parts for cracks and other damage.

Repair or replace any damaged parts.

SIM Covers

SIM Cassette compartment

SIM Control and display panel

SIM Exposure release cable

SIM Single tank generator

SIM Collimator

- Make sure that neither the single tank generator nor the collimator have any mechanical damage that could affect radiation protection.

SIM DAP (optional)

- Make sure there are no scratches on the DAP ionization chamber. Make sure the cable and the connector are intact. Make sure the DAP display is intact as well.

2.2 Mechanical inspection

2.2.1 Rear wheels

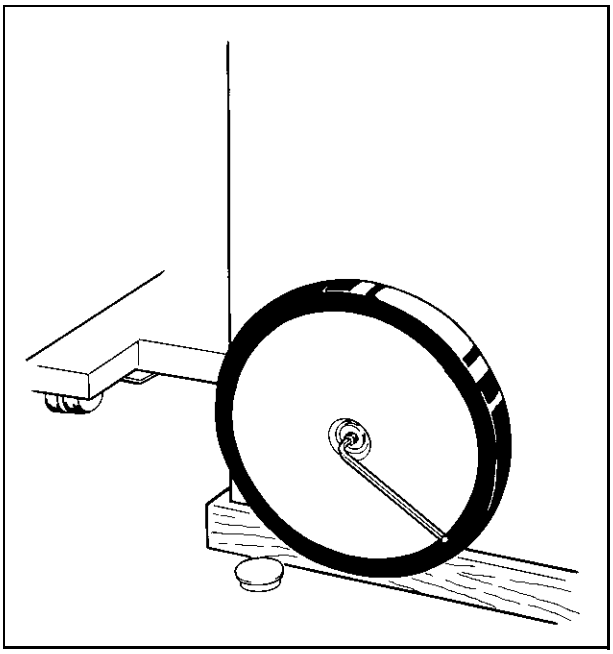

Fig. 1:

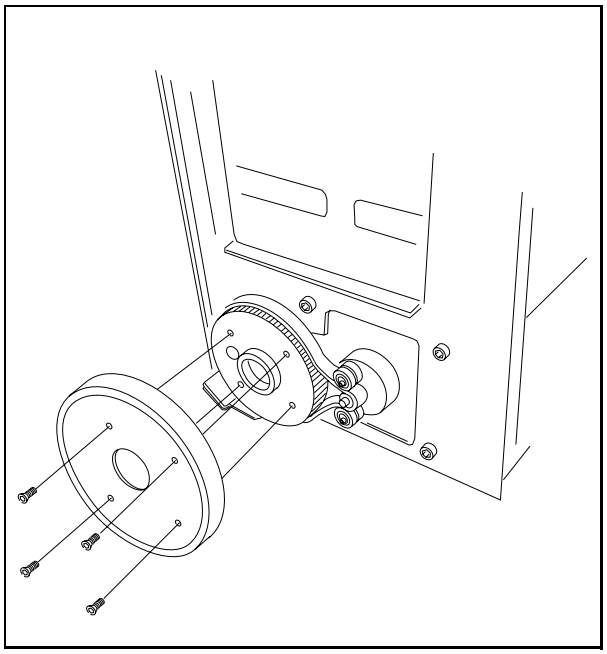

Fig. 2:

- Jack up one side of the unit with a piece of wood (Fig. 1 / p. 25).
- Secure the rear wheel on the other side with two blocks. Do not apply the parking brake.
- Remove the wheel:
  - for MOBILETT Plus/Plus E (Fig. 1 / p. 25)
  - for MOBILETT Plus M (Fig. 2 / p. 25)

SIM **Drive belt (for MOBILETT Plus M only)**

- Check the condition and tension of the drive belt.

NOTE	**Under normal operating conditions, the drive belt does not require adjustment throughout the lifetime of the system.**

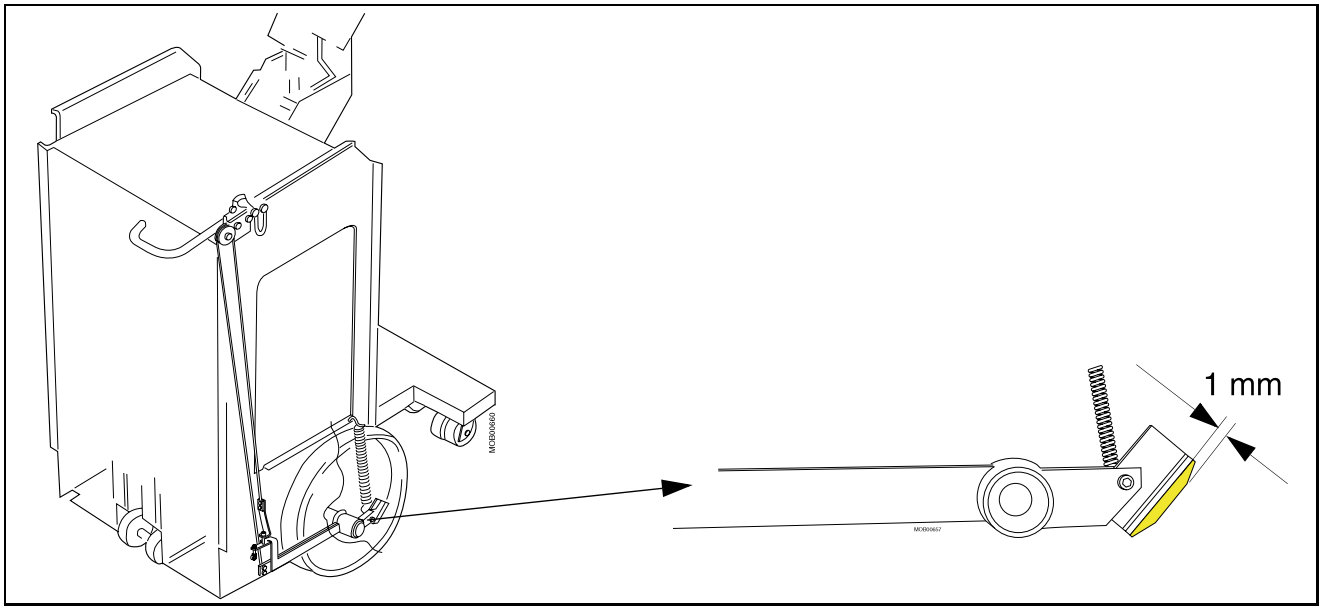

Fig. 3:

SIM **Brake lining**

- Check the brake lining (Fig. 3 / p. 26). If the lining is worn down to less than 1 mm, it must be replaced. Refer to the section on ”Adjustment of the hand brake/parking brake” in the service instructions.
- Remount the wheel.

SIM **Secure mounting**

SIM **Ease of movement**

- Check that the wheel is securely mounted and that it turns freely.
- Check the other wheel following the same procedure.

2.2.2 Front wheels

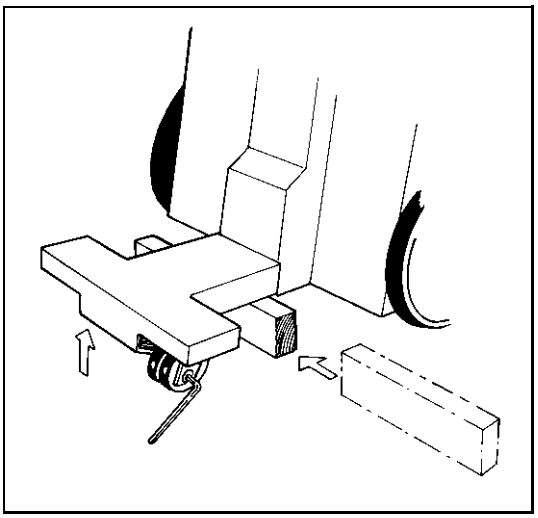

Fig. 4:

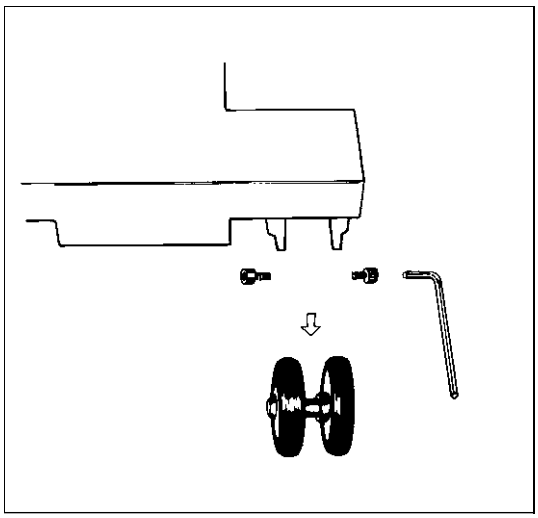

Fig. 5:

- Lock the rear wheels with the parking brake.
- Lift up the front wheels using the tilt bar and jack them up with a piece of wood (Fig. 4 / p. 26).

SIM Secure mounting

SIM Ease of movement

- Check that the wheels are securely mounted and that they turn freely. If necessary, tighten the Allen screws (Fig. 4 / p. 26).

PMP Cleaning

If the wheels need thorough cleaning, they must be removed:

- Remove the Allen screws.
- Remove the wheels (Fig. 5 / p. 26).
- Clean the wheels.
- Remount the wheels.
- Check the other set of wheels in the same way.

2.2.3 Supporting wheels

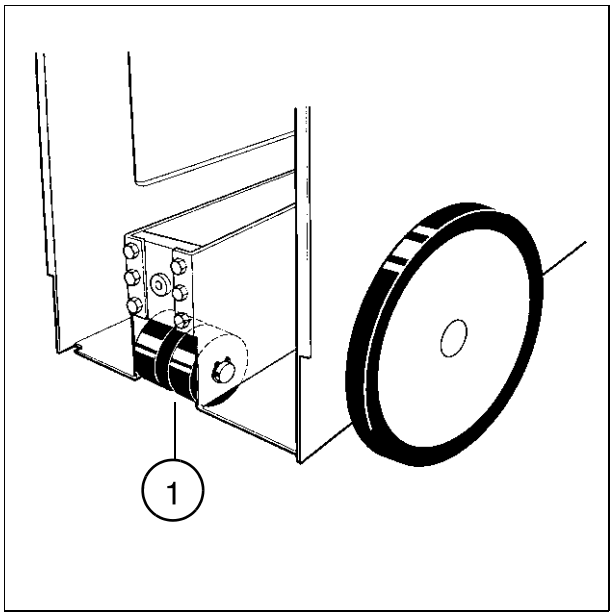

Fig. 6:
Pos. 1 Supporting wheels

- Lock the rear wheels with the parking brake.
- Jack up one side of the unit with a piece of wood.

SIM Ease of movement

SIM Damage

- Check that the supporting wheels turn freely and do not show any signs of damage. If they must be replaced, refer to ”Replacing the supporting wheels” in the service instructions.

2.2.4 Turn plate (MOBILETT Plus/Plus M only)

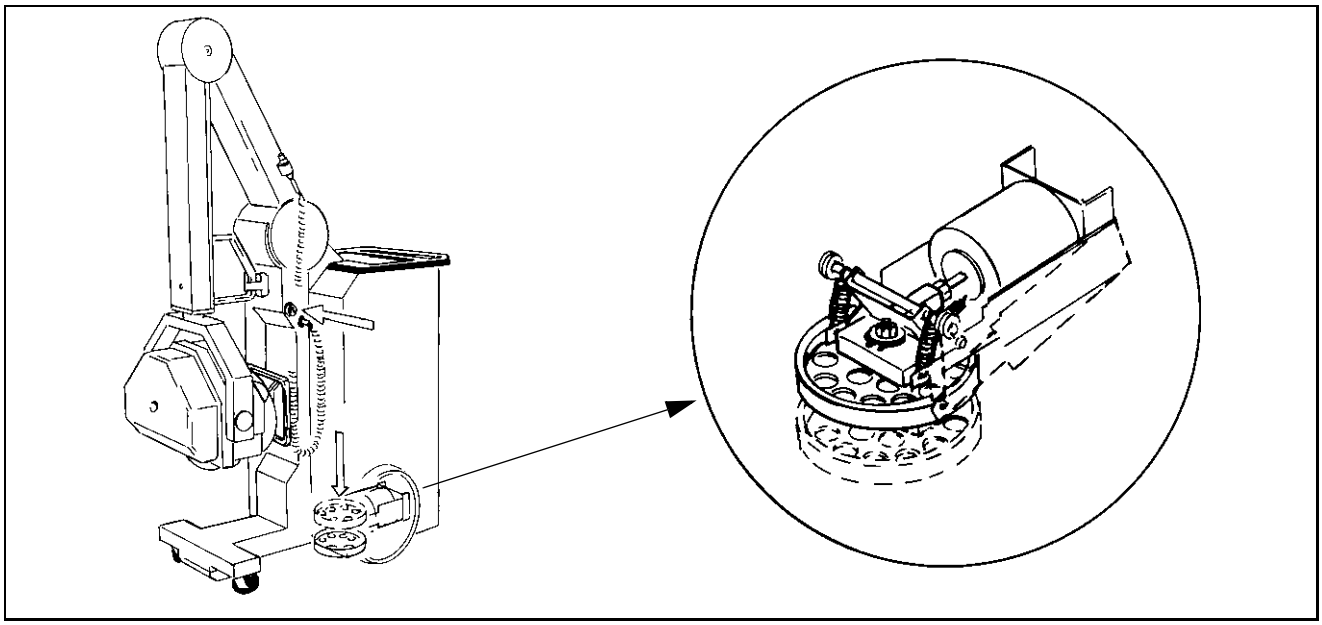

Fig. 7:

- Connect the mains cable and switch the system ON.
- Move the unit to a level surface.

PMF Button illumination

- Press one of the turn plate buttons. The buttons must light up when the turn plate is activated.

PMF Function

- Check whether the system can be rotated around the turn plate (Fig. 7 / p. 28).
- Press the turn plate button again and check whether the turn plate retracts to the parking position.
- Repeat the same test with the other turn plate button. If a problem arises, proceed according to the section ”Adjustment and replacement of the turn plate” in the service instructions.

2.2.5 Brakes

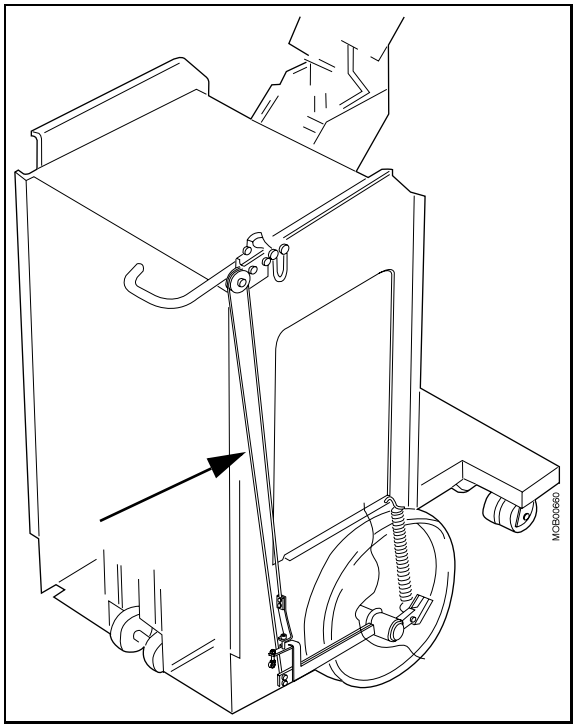

Fig. 8:

⚠WARNING **There is a risk of life-threatening electric shock.**

➪ **Make sure protective measures have been taken prior to opening the unit.**

➪ **Disconnect the system from the mains.**

➪ **(Protective measures when working on the capacitor bank / p. 14).**

SIM Uniformity

SIM Braking force

SIM Locking

- Check whether the hand brake is sufficient to stop the unit and that it does not pull to the left or the right when the brake is applied.
- Lock the brake.
  - ➪ It should not be possible to push the MOBILETT using average force. Slight skidding is permissible when applying a force greater than 350 N.
- Remove the front, rear, left and right covers.
- The brake force can be increased by increasing the tension on the brake cable (Fig. 8 / p. 29). Additional information can be found in the section on ”Adjustment of the hand brake/parking brake” in the service instructions.

2.2.6 Transport safeguard

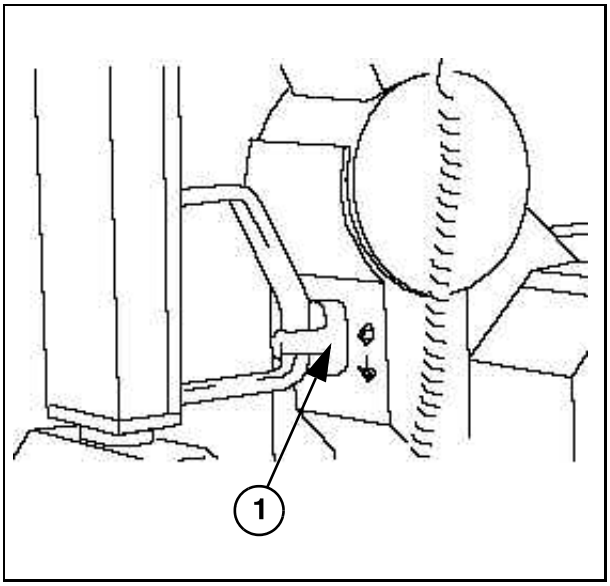

Fig. 9:

Pos. 1 Transport safeguard

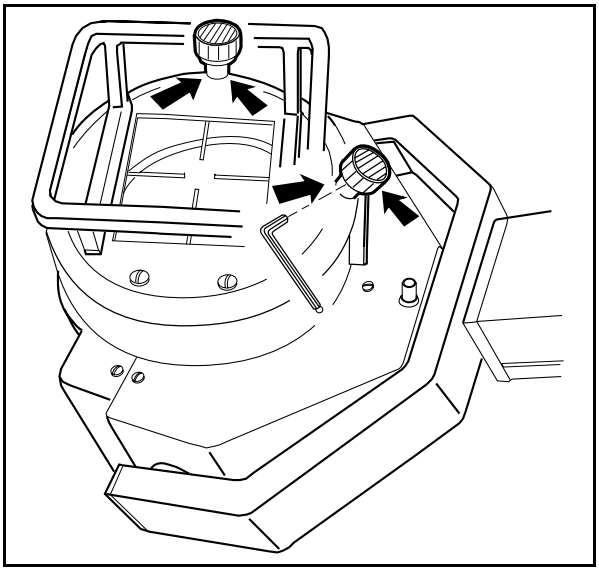

Fig. 10:

SIM Damage

SIM Locking

- Check the transport safeguard (Fig. 9 / p. 30) for mechanical damage. In case of damage, the transport safeguard must be replaced.
- Check that the handle of the arm system locks securely into the transport safeguard.

2.2.7 Handles

SIM Mounting

- Check that the handle of the support arm is securely mounted. If necessary, tighten the screws with a torque of 15-20 Nm.

2.2.8 Collimator adjustment knobs

SIM Mounting

- Check whether the adjustment knobs on the collimator are tightened securely (Fig. 10 / p. 30).

  If necessary, tighten both Allen screws on each of the knobs.

2.2.9 Arm system and single tank

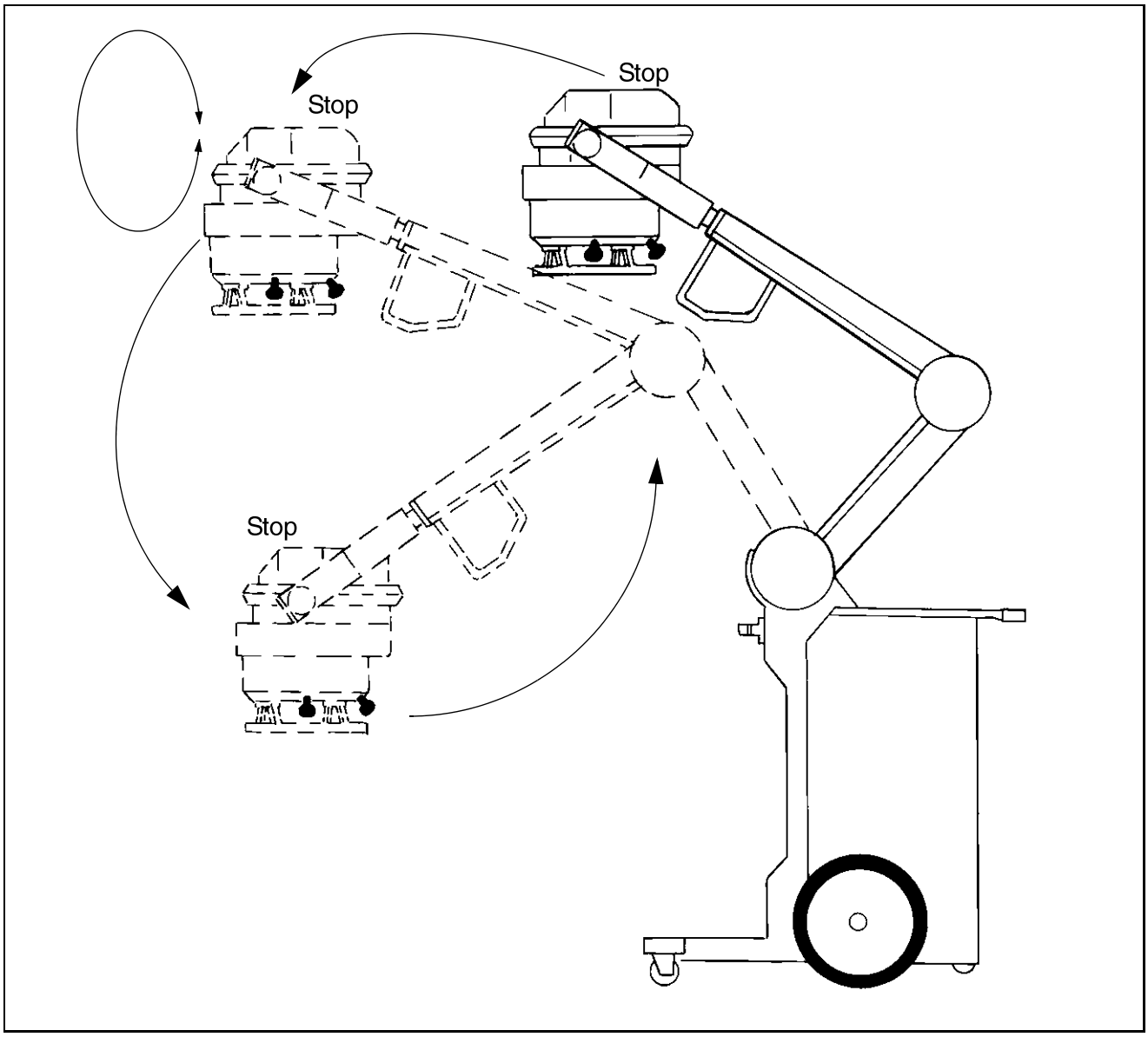

Fig. 11:

SIM Movement of the arm system and the single tank

- The entire arm system including the single tank must not move by itself in any position. However, it must be easy to move to a new position. If this is not the case, proceed according to the section ”Adjusting the friction linings” in the service instructions.

SIM Movement of the single tank fork

- Check that the single tank fork can be easily turned and stays in any desired position.

SIM Single tank movement

- Check that the single tank moves easily in the fork and stays in any desired position.

2.2.10 Mains cable

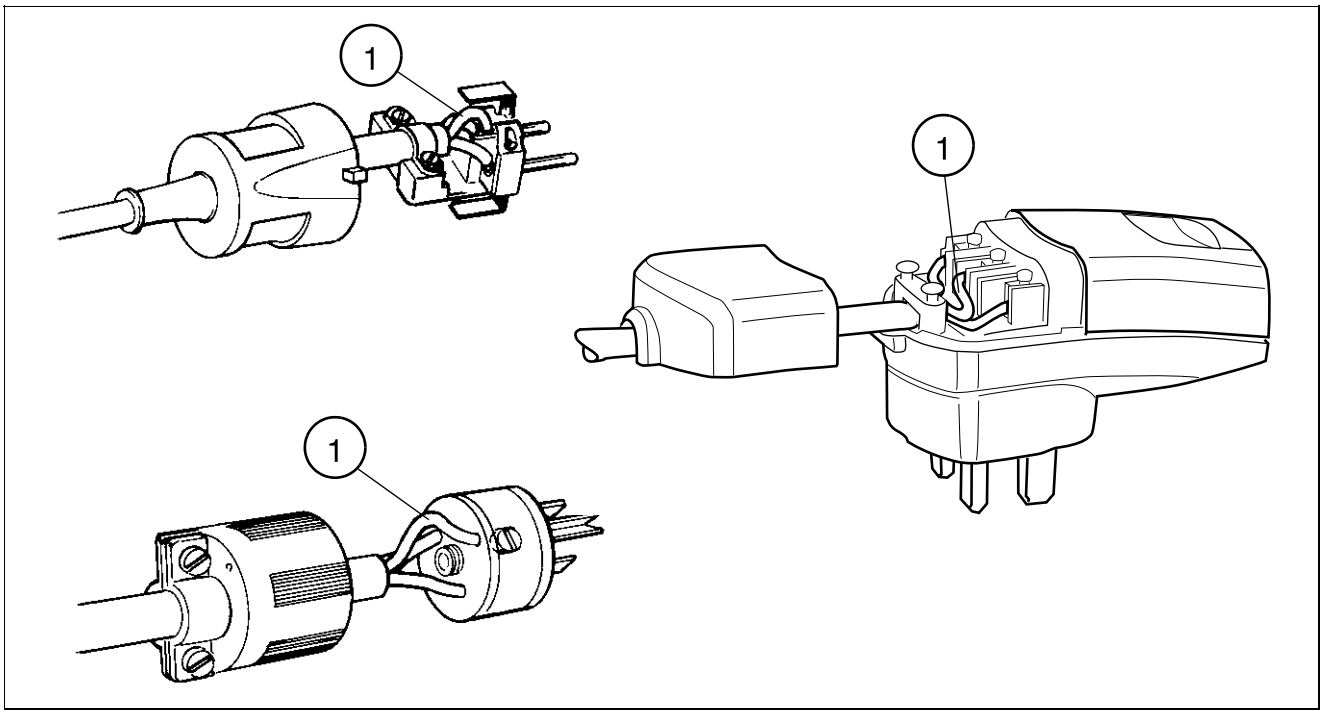

Fig. 12:
Pos. 1 Protective conductor

PMP Replace the cable winder every 4 years (units with cable winder only).

- The cable winder should be replaced every four years.

SIM Cable winder (for units with cable winder only)

- Move the cable up and down while winding it, in order to avoid any slack, until the cable is completely rolled up. Ensure proper functioning of cable winder and brake.

PMP Replace the mains cable every 2 years.

- The mains cable must be replaced every two years.

NOTE

New cable winder 65 08 746 comes with the new mains cable. Therefore, it is not necessary to replace the mains cable, if the cable winder has been replaced already.

SIM Damage

- Check the mains cable and plug for damage. If necessary, replace them.

PMP Cleaning

- Clean the mains cable using a paper towel dampened with a lukewarm solution of water and a household cleaning agent.

SIM Protective conductor

- Disconnect the power supply plug.

- Check the protective conductor connection to the plug. The protective conductor must be securely attached and must be slightly longer than the other two wires. This applies for all plug types.
- Close the plug after inspecting it.

2.2.11 Arm system mounting

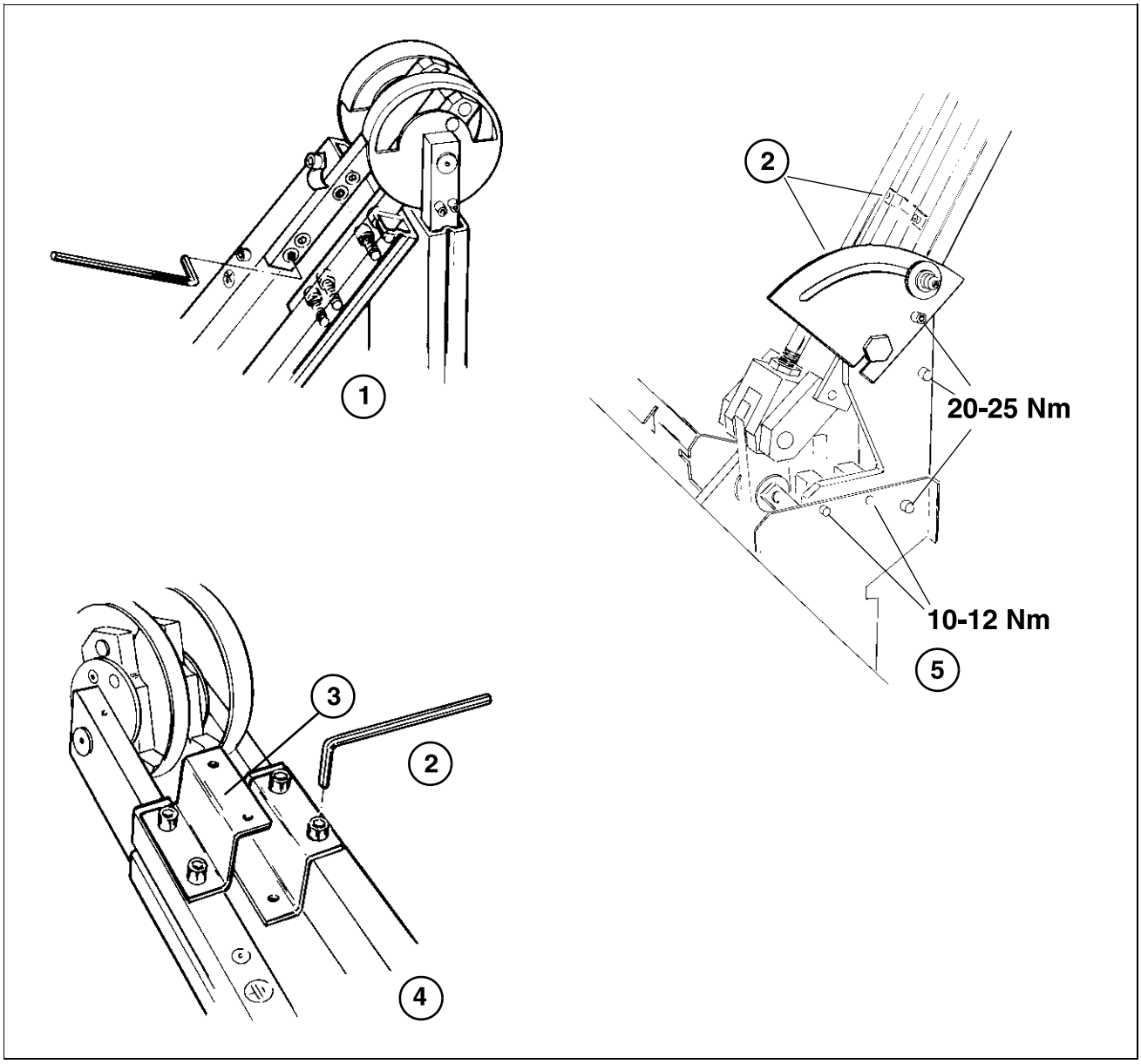

Fig. 13:

Pos. 1	Upper link (check without torque)
Pos. 2	Check without torque
Pos. 3	Nut
Pos. 4	Upper link
Pos. 5	Lower link

- Remove the arm covers as well as the upper and lower cover plates of the column. The lower column cover can be lifted up.

SIM **Screws and lock nuts**

- Check that all the screws and lock nuts on the arm system are tightened securely (Fig. 13 / p. 33).

2.2.11.1 Adjustment screw

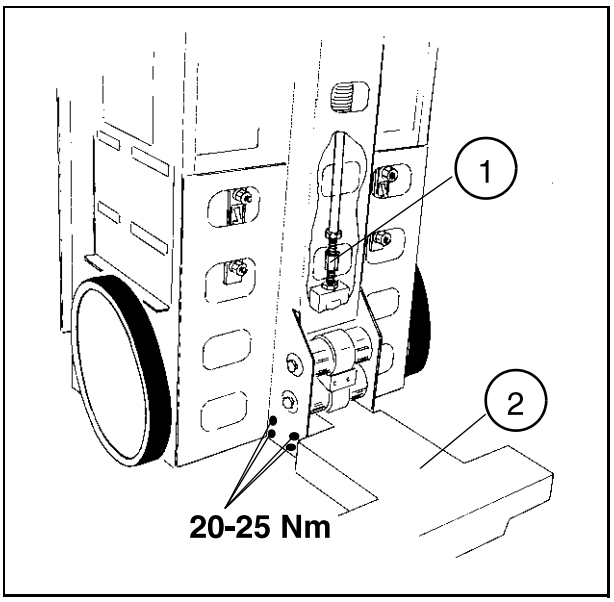

Fig. 14:
Pos. 1 Adjustment screw (check without torque)
Pos. 2 Foot

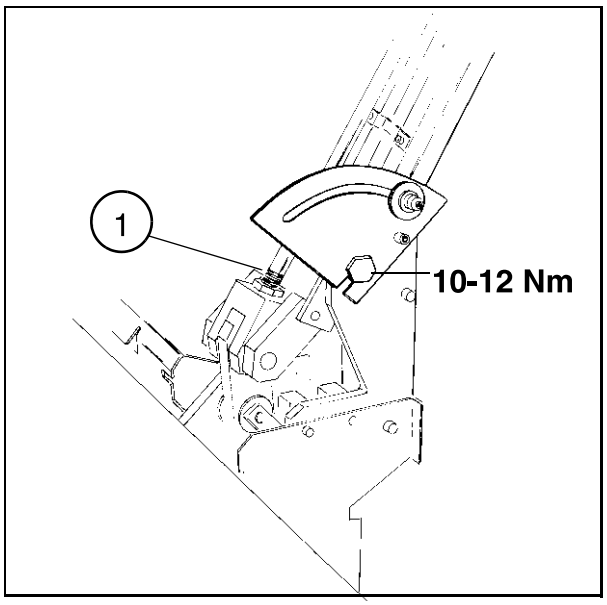

Fig. 15:
Pos. 1 Check without torque

⚠WARNING **If the screw is loosened, the arm might fall!**

- ➪ **When checking the adjustment screw, do not loosen the nuts or turn the adjustment screw.**
- ➪ **Avoid loosening the screw and the nuts.**

SIM **Lock nuts**

- Check the lock nuts on the adjustment screw (Fig. 14 / p. 34).

SIM **Base mounting**

- Check the base mounting in the chassis (Fig. 14 / p. 34).

2.2.11.2 Arm connecting piece

SIM **Screws and nuts**

- Remove the cover of the lower connecting piece.

NOTE	**Note the assembly sequence.**

- Check the screws and nuts on the connecting piece (Fig. 15 / p. 34).

2.2.11.3 Single tank fork

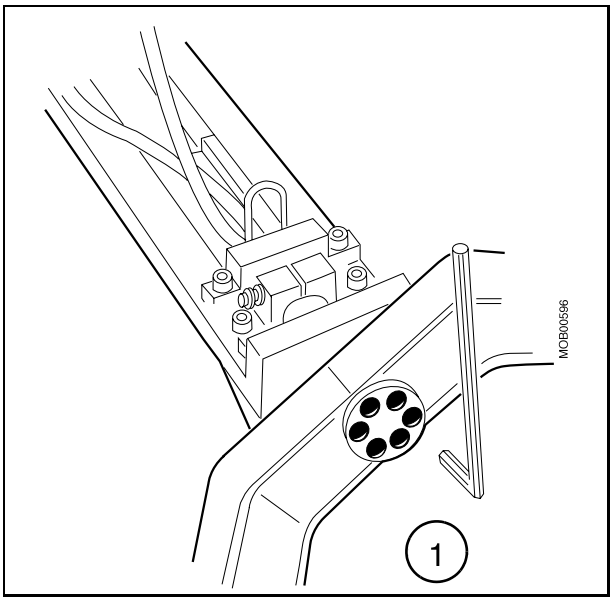

Fig. 16:
Pos. 1 Check without torque

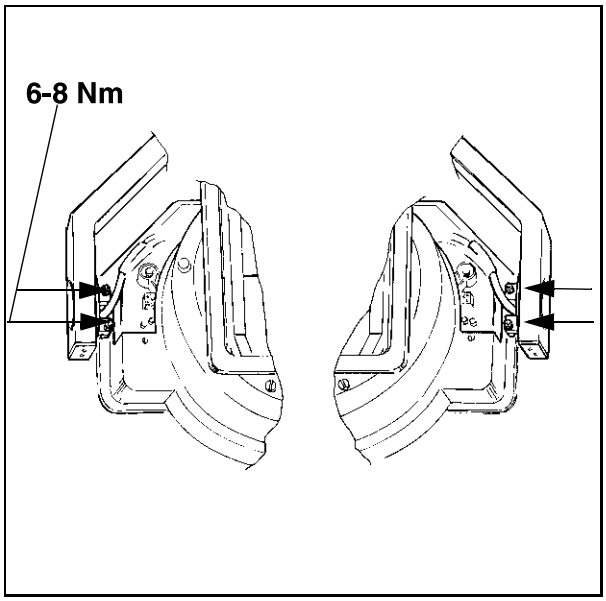

Fig. 17:

SIM **Screw connections on the fork**

- Check and tighten all screw connections of the fork on the support arm (Fig. 16 / p. 35).

SIM **Single tank screw connections**

- Check the four screw connections of the single tank. They are accessible from the top side of the single tank without removing the cover (Fig. 17 / p. 35).

2.2.11.4 Lubrication

Remove the cover of the column stand.

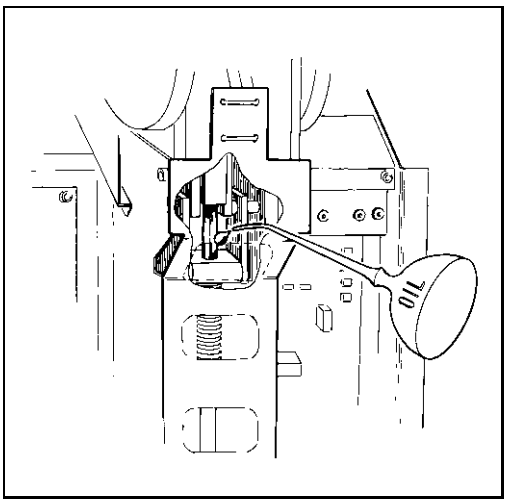

Fig. 18:

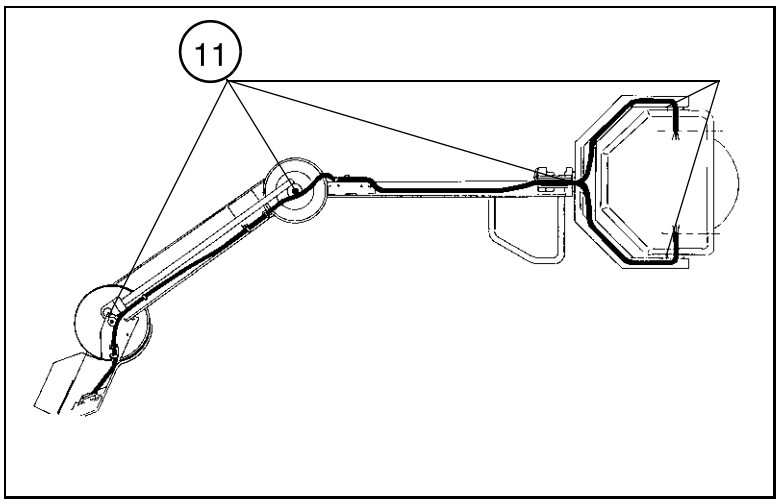

Fig. 19:
Pos. 11 Rotation wear

PMP Glide bushing on the connecting rod

Lubricate the glide bushing on the connecting rod (Fig. 18 / p. 36).

2.2.12 Arm cable harness

SIM Damage

- Check all the cables for damage. Closely inspect the areas that are frequently subjected to torsion strain (Fig. 19 / p. 36).
- Replace any damaged or broken cables. If you cannot determine any direct cause for the damage, replace all cable harnesses.

  Refer to the section entitled ”Replacement of the support arm cable harness” in the service instructions.

2.3 Motor batteries (MOBILETT Plus M only)

PMF Battery voltage

- Check the battery voltage (+ 24 V) at K103 (2 each 12 V batteries in series).

PMF Condition

- In order to assess the condition of the batteries, ask the operating personnel whether the batteries need to be recharged more frequently than previously. If this is the case, the batteries should be replaced.

PMF Charging indicator

- Check that the charging indicator is functioning correctly.

2.4 Service mode

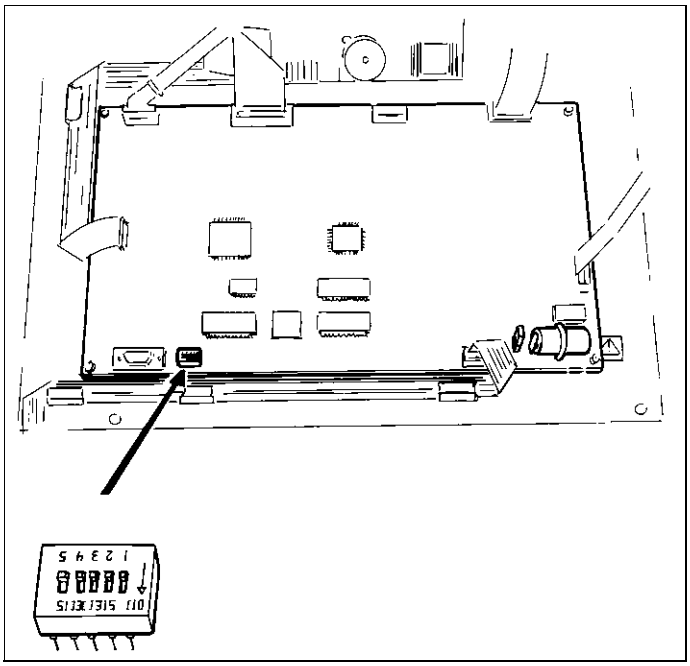

Fig. 20:

- Reattach all cover parts with the exception of the upper system cover.

NOTE	**Switch S10 on D7 OFF prior to the following inspection.**

Entering service mode

Switch S1:1 on board D1 must be switched over (S1:1 to ON) to call up the service program. The program version is then displayed:

kV	mAs
vEr	**x.x** = version x.x

(depends on the software version installed)

(To exit the service mode, switch S1:1 on board D1 must be switched back to OFF. This will cause any program that is still running to be shut down.)

Selection of test programs with buttons "kV+/ -"

Several test programs are available. The respective program number appears in the kV window of the display while the mAs window remains blank. Example of the display for program no. 6:

kV	mAs
P06	

Pressing the ”kV+” button calls up the next test program. As soon as the last test program has been reached and ”kV+” is pressed again, the display begins again with the program version.

The "kV-" button allows you to run the test programs in reverse order. The "collimator lamp" button is used for the ON/OFF function, i.e., it starts or stops the displayed test program.

Example of the display for P06 after activation of the collimator lamp (starts the formation of the capacitor bank):

kV	mAs
CAP	**For** = capacitor formation program

The test program is stopped by pressing the "collimator lamp" button a second time. Example of the display for P06:

kV	mAs
P06	**Stop**

Program P06 is now stopped. A new service program can be selected with the ”kV+/-” buttons or program no. 6 can be restarted by pressing the "collimator lamp" button.

NOTE

Messages appearing in service mode, with the exception of "Quick adjustment", are only displayed, i.e. they are not incorporated in the error memory.

2.5 Maintenance tests

Use these service programs to check the display, filament heating, rotating anode and capacitors.

While the test is running, observe the display. If an error is determined during the course of the test, the program is interrupted and the associated error is displayed, accompanied by an audible signal.

Additional information about each test can be found in the section "List of test programs available in service mode" in the service instructions. The test sequences are also described in this section.

- Start the programs by activating the collimator lamp.

SIE Display test

PMF Filament test

PMF Rotating anode test

PMF Capacitor bank and charge test

P04		Display test. Check whether the display and the LEDs light up and whether the buzzer sounds. The test will automatically be repeated once.
P01		Filament test. When the test is successfully completed, the following message will appear for 4 seconds:
FIL PASS	=	The filament test was successfully completed.
P02		Rotating anode test. During this test, rotating anode start-up is checked and the rotation frequency is displayed. The following message appears when the test has been successfully completed:
rot PASS	=	The rotating anode test was successfully completed.
P03		Capacitor bank and charge test. During the test, the actual voltage in the capacitor bank is displayed. The following message appears when the test has been successfully completed:
CAP PASS	=	The capacitor bank and charge test was successfully completed.

If an error is determined during any of the tests, the current program stops and the following message appears:

Err xx	=	Test results are "not valid".

2.6 Backup battery G1/D1

PMP Replace every 5 years

The backup battery (3.0 V, 1.2 A lithium battery) on board D1 must be replaced every 5 years. Refer to the section ”Replacing the backup battery” in the service instructions.

PMF P11 - Backup battery test

The status of the backup battery can be checked using service program P11.

After activating program no. 11 via the "collimator lamp" button, the battery voltage is displayed:

kV	mAs
bAt	**3.2 = 3.2 volts**

If the battery voltage is 2.9 V or less, the battery must be replaced. Refer to the section ”Replacing the backup battery" in the service instructions.

After 5 seconds, the program ends. If the battery voltage is too low, the following message appears and an audible signal sounds:

kV	mAs
P 11	**CAL31**

If the battery voltage is within the correct range, the following message appears:

kV	mAs
P 11	**PASS = battery charge is okay**

Exit the service mode by switching S1:1 on board D1 OFF. This will end all currently running programs.

2.7 Test of kV accuracy

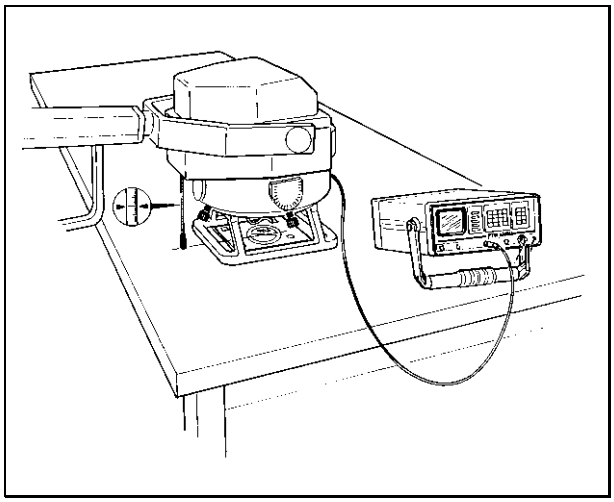

Fig. 21:

Requirement:

The measured kV values must lie within the limit values listed in the table.

NOTE

If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.

Required measurement devices:

kV meter that works with the filter comparison method, e.g. the PTW Nomex. Use the correction factor indicated in the kV meter operating instructions for non-invasive kV measurements. If there is no kV meter available, the measurement can also be performed with an oscilloscope at test points "HTPEAK" and "GND" on board D1. The measurement result is 40 kV/V.

NOTICE

Increased filtration leads to higher kV values.

The actual filtration of MOBILETT can be taken from the test protocol.

➪ **If the actual inherent filtration is not known, make the correction with a value of 5 mm Al.**

Procedure:

- Prepare the kV meter for the measurement (refer to the operating instructions for the kV meter).
- Place the measuring detector on a tabletop or other suitable surface. Using the collimator lamp, check whether the detector is located in the radiation field (Fig. 21 / p. 42).
- Set the SID according to the information given in the operating instructions for the kV meter.

- Set the following exposure parameters and release an exposure:

kV meter selection	Exposure parameter		Limit values* to be maintained
DC voltage	52 kV	50 mAs	49.0-55.0 kV
	81 kV	20 mAs	77.0-85.0 kV
	MOBILETT Plus/Plus M		MOBILETT Plus/Plus M
	133 kV	20 mAs	126.4-139.6 kV
	MOBILETT Plus E		MOBILETT Plus E
	125 kV	20 mAs	118.8-131.2 kV

* The measurement inaccuracy of the respective measurement device must be subtracted from these limit values.

Setting

- Proceed according to section "P10 - Fast adaptation" in the service instructions in order to adjust excessively high deviations.

PMF 52 kV, 50 mAs

PMF 81 kV, 20 mAs

PMF 133 kV, 20 mAs

PMF 125 kV, 20 mAs

2.8 Test of mAs accuracy

Requirement

The actual product of the exposure time and tube current (mAs) must match the displayed value within the limits established by Siemens.

Required measurement devices:

Storage oscilloscope with a measurement accuracy of ± 2.5 %.

Procedure:

- Close the collimator.
- Connect the oscilloscope to test points ”MAPOS” and ”GND” on board D1.
- Switch on the X-ray system and the oscilloscope and wait approximately 5 minutes until the units have stabilized.

Example: Calculating the mAs

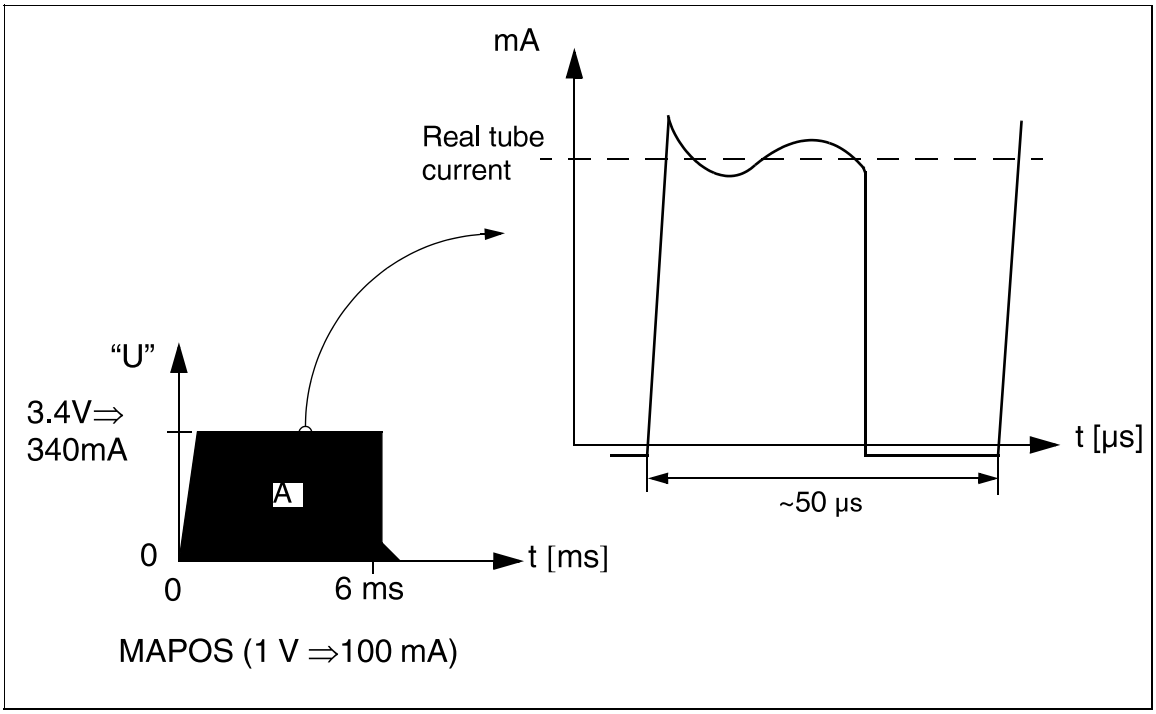

Fig. 22:

The mA signal is comprised of a series of pulses. To get the real tube current, it is necessary to use an oscilloscope with the possibility of showing part of the time sweep expanded so that each current pulse is clearly visible. The current can then be measured according to the figures above.

The mAs value can be calculated using the information displayed on the oscilloscope.

Surface ”A” corresponds to the mAs value.

mAs	=	Tube current x exposure time	
mAs	=	340 mA x 0.006 s	= 2.0 mAs

NOTE

The signal contains a high frequency of 20-40 kHz, which can lead to measurement problems with the oscilloscope (aliasing effect). Always use an oscilloscope with a high sampling rate.

- Calculate the product of the tube current x the exposure time for the following exposure parameters:

Set on the control and display panel		Acceptable mAs value*
kV	**mAs**	
40	5	4.7 - 5.3
81	2	1.9 - 2.1
MOBILETT Plus/Plus M		9.5 - 10.5
133	10	
MOBILETT Plus E		
125		

* The measurement inaccuracy for the measurement device must be subtracted from these limit values.

- Determine whether the mAs product (tube current + reactive current) x exposure time lies within the indicated tolerances.

Setting

- Proceed according to section "P10 - Fast adaptation" in the service instructions to eliminate slight deviations.

PMF 40 kV, 5 mAs

PMF 81 kV, 2 mAs

PMF 133 kV, 10 mAs

PMF 125 kV, 10 mAs

2.9 Check for reproducibility

Requirement:

USA

- The coefficient of fluctuation of the radiation dose may not be greater than 0.045 for any combination of exposure parameters if the X-ray system is supplied with line voltage as specified by Siemens.

NOTE

The following test requires 10 sequential exposures, which must be taken within one hour.

After each measurement, the exposure parameters should be set to different values for a short time.

If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.

Required measurement devices:

- Dose meter

Procedure:

- Wait until the system has reached thermal stability. A 15 minute warm-up time is required for the generator to be ready.

- Release the specified number of exposures with the following exposure data:
  - 85 kV, 1.0 mAs, 10 exposures.
- Measure the dose for each exposure with the dose meter.
- Reset the measurement display prior to each new measurement.

Calculations: Fluctuation coefficient C

- The fluctuation coefficient C for a dose measurement sequence of 10 exposures is:

$$c = \frac{s}{\overline{x}} = \frac{1}{\overline{x}} \left[\sum_{i=1}^{n} \frac{(x_i - \overline{x})^2}{n - 1} \right]^{1/2}$$

Fig. 23:

Where:

s	=	standard deviation of the measurements
$\overline{x}$	=	average measurement value of the sequence
x_i	=	i-th measurement value of the sequence
n	=	number of measurements in the measurement sequence

The fluctuation coefficient C must be ≤ 0.045.

Setting

- If the value for the calculated fluctuation coefficient is higher than 0.045, the reason for the deviation must be determined and corrective measures must be taken.

  Refer to section "P10 - Fast adaptation" in the service instructions.

QSQ Fluctuation coefficient C

Steps for calculating C

Example:

The values used in the example are not real values.

- Release 10 exposures and record the measured values.

Exposure (n=10)	Measured values (xi)
1	1.01
2	1.02
3	1.03
4	1.04
5	1.03
6	1.02
7	1.02
8	1.01
9	1.03
10	1.04

- Add the measured values:

  $\Sigma = 1.01 + 1.02 + 1.03 + 1.04 + 1.03 + 1.02 + 1.02 + 1.01 + 1.03 + 1.04 \Rightarrow S = 10.25$

- Calculate the average value:

$$\bar{x} = \frac{\Sigma}{n} = \frac{10.25}{10} \Rightarrow \bar{x} = 1.025$$

Fig. 24:

- Calculate the standard deviation:

$$s = \sqrt{\frac{(x_i - \bar{x})^2}{n - 1} + \ldots}$$

Fig. 25:

$$\sqrt{\frac{(1.01-1.025)^2}{9}+\frac{(1.02-1.025)^2}{9}+\frac{(1.03-1.025)^2}{9}+\frac{(1.04-1.025)^2}{9}+\frac{(1.03-1.025)^2}{9}+\frac{(1.02-1.025)^2}{9}+\frac{(1.02-1.025)^2}{9}+\frac{(1.01-1.025)^2}{9}+\frac{(1.03-1.025)^2}{9}+\frac{(1.04-1.025)^2}{9}}=s$$

Fig. 26:

$$\sqrt{2.5\times10^{-5}+2.8\times10^{-6}+2.8\times10^{-6}+2.5\times10^{-5}+2.8\times10^{-6}+2.8\times10^{-6}+2.8\times10^{-6}+2.5\times10^{-5}+2.8\times10^{-6}+2.5\times10^{-5}} \Rightarrow s = 0.0108$$

Fig. 27:

- Calculate the coefficient:

$$C=\frac{s}{x}=\frac{0.0108}{1.025}=0.0105$$

Fig. 28:

$\Rightarrow$ In this example, C = 0.0105 and is therefore ≤ 0.0450,
i.e. the generator is within the specifications.

- Reattach the upper cover.

2.10 Remote exposure switch system (optional)

- Check the function of the remote exposure switch system by switching on the collimator light and releasing an exposure.

SIE Function of the remote exposure switch system

PMP Replace the remote control battery every year.

2.11 DAP measuring system (optional)

- Press the test button on the display. The value on the display should be in the range 80-120 µGym^2 (DAP resolution 0.1 µGym^2) or 8-12 µGym^2 (when using a highly sensitive chamber, i.e. DAP resolution 0.01 µGym^2). If not, calibrate the system according to the service instructions.

- Check the function of the DAP measuring system by releasing an exposure. Check if a measured value is shown on the display.

SIE **Function of the DAP measuring system**

2.12 Replacing the collimator lamp

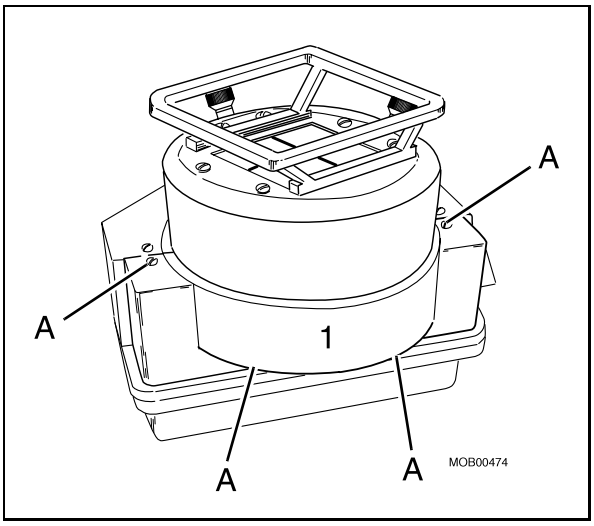

Fig. 29:

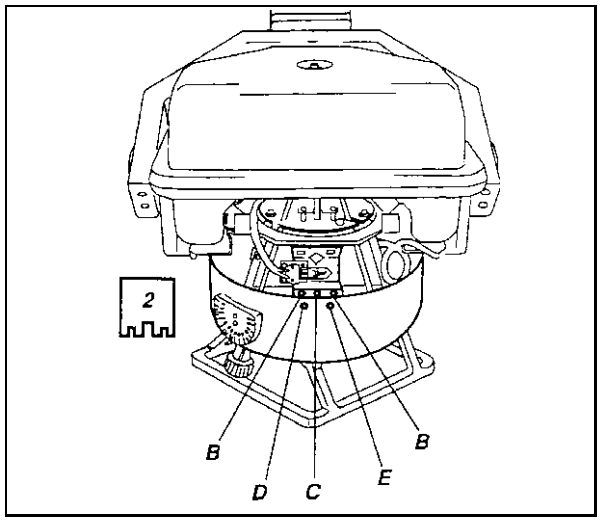

Fig. 30:

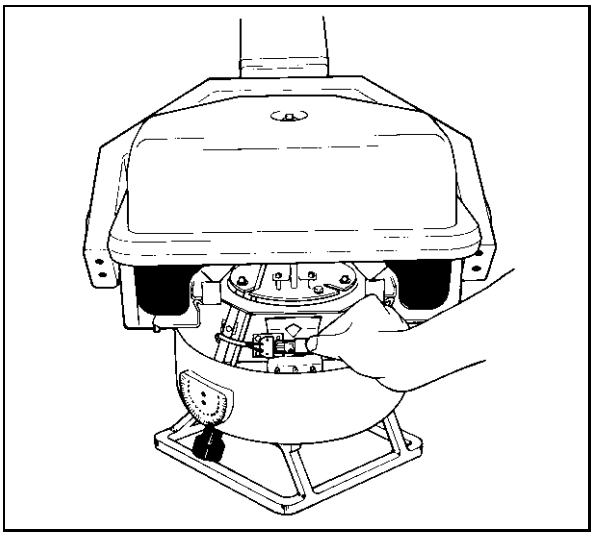

Fig. 31:

PMP Replace every year

- The collimator lamp must be replaced every year.

- Remove the cover (1/Fig. 29 / p. 51) by removing the four screws marked ”A” (Fig. 29 / p. 51). Turn the collimator so that the lamp housing is accessible.
- Remove the protective plate (2/Fig. 30 / p. 51) covering the collimator lamp. Loosen the screws marked ”B” by one turn. Do not remove them. Do not remove nuts ”C”, ”D” and ”E” in this process (Fig. 30 / p. 51).
- Remove the lamp and replace it with a new lamp, (Fig. 31 / p. 51). **Do not touch the glass bulb with your fingers**.

- Reinstall the protective plate and tighten the screws marked ”B”.
- Reattach the cover (1/Fig. 29 / p. 51).

PMF Function of the collimator lamp

- Check the function of the collimator lamp.

2.13 Checking the luminance

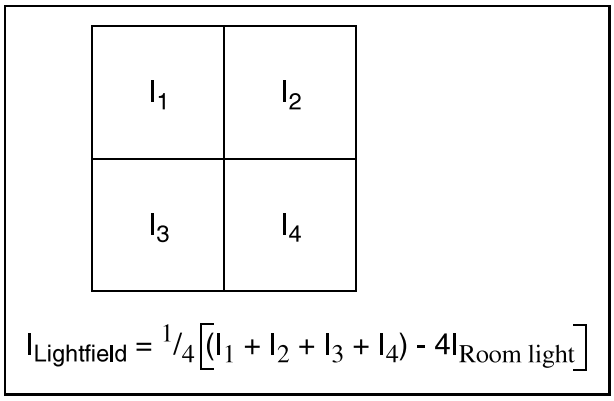

Fig. 32:

Required measurement devices: lux meter

NOTE	**If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.**

PMF Luminance

USA

If the collimator lamp is switched on for the purpose of illuminating the radiation field, the average luminance must be 180 lux at a distance of 100 cm. The average luminance is determined by taking measurements in the approximate center of each of the four quadrants of the light field, (Fig. 32 / p. 53).

2.14 Coincidence of radiation and light fields

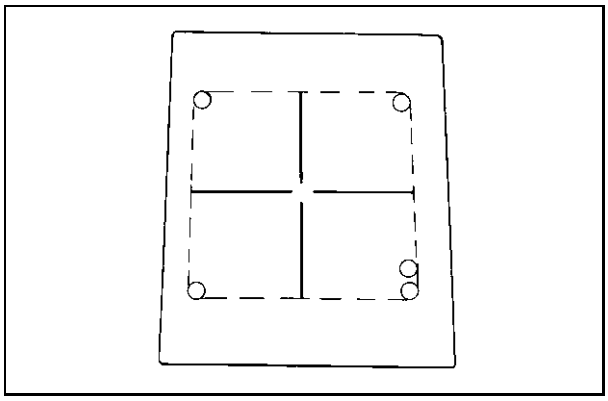

Fig. 33:

NOTE	**If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.**

- Insert a film into the 35x35 cm (14"x14") cassette.
- Place the cassette on a table or similar surface.
- Set the SID to 100 cm (39") (use a tape measure).
- Switch the collimator lamp on and align the cassette. Now collimate the light field to 25x25 cm (10"x10").
- Mark the four corners of the light field with coins and identify one of the corners with an additional coin, (Fig. 33 / p. 54)

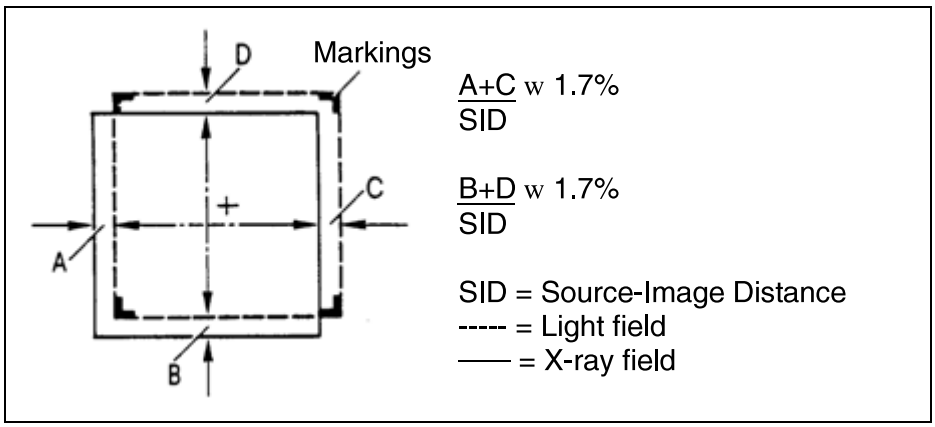

Fig. 34:

- Set 52 kV and 2.0 mAs on the control and display panel.
- Release an exposure.
- Develop the film and measure the deviation between the light and radiation fields. A deviation of ± 1.7% of the SID is acceptable. (Fig. 34 / p. 54)

- If the deviation is larger than 1.7%, correct the coincidence of the light and radiation fields by adjusting the nuts marked "D" and "E". (Fig. 30 / p. 51)
- Check the setting by releasing another exposure.
- If necessary, repeat the adjustment until the deviation of the light and radiation fields lies within the acceptable tolerance.

QSQ Deviation ((A + C) / SID)

QSQ Deviation ((B + D) / SID)

2.15 Checking the radiation indicator

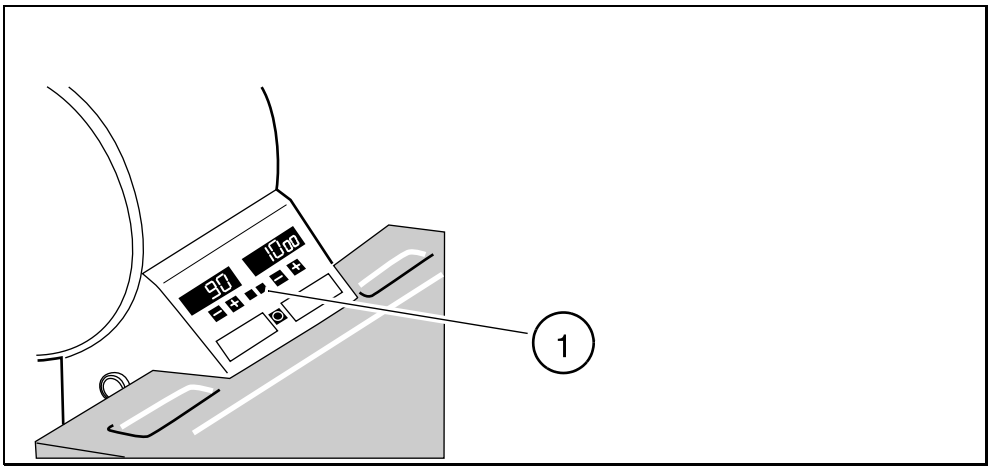

Fig. 35:
Pos. 1 Exposure light indicator

- Set 81 kV and 10 mAs.

- Release an exposure and check whether an indicator lights up on the control and display panel and an audible signal sounds at the end of the exposure.

SIE Radiation indicator

SIE Audible signal

2.16 Checking the manual exposure interrupt

The user must be able to interrupt the exposure at any time.

- Set 55 kV, 160 mAs for MOBILETT Plus/Plus M.
- Set 55 kV, 80 mAs for MOBILETT Plus E.

- Release an exposure and immediately interrupt it by letting go of the exposure switch. The message ”USE 20” appears on the display indicating that the exposure release switch was interrupted during the exposure. In addition, 10 short "beep" signals sound.

- The message can be erased by pressing the ”kV+” button.

SIE Message "USE20"

SIE 10 short beep signals

NOTE	**All covers must be remounted.**

2.17 Protective conductor measurement

- Perform the protective conductor test, with all system covers closed, according to ARTD-002.731.17... (Safety-Related Rules for Installation and Maintenance). The measured values are to be entered in the maintenance protocol. The protective conductor resistance must not exceed 0.2 ohms.

SIE	Measured value

2.18 Equivalent leakage current measurement

- Measure the equivalent leakage current according to ARTD-002.731.17... (Safety-Related Rules for Installation and Maintenance).

  The measured values are to be entered and evaluated in the maintenance protocol.

  The limit values of 2 mA must not be exceeded.

NOTE	**Evaluate the results by comparing the first measured value to the corresponding value of preceding maintenance procedures or safety checks. A sudden or unexpected increase in the measured values may indicate that an error occurred in the primary circuit of the power supply (damaged insulation, damage caused by water ingress or humidity, etc.) – even if the limit value of 2 mA is not exceeded.**

SIE	Measured value

2.19 Cleaning the system

- Clean the system with a cloth dampened with a lukewarm solution of water and a commercially available cleaning agent. Refer to the section on "Cleaning" in the instructions for use.

PMP Cleaning

2.20 Checking the kV and mAs displays

- Check whether the green "ready" lamp lights up approximately 2 minutes after the system is switched on. If it doesn't light up, an error message will appear on the display. Refer to the chapter "Display messages" in the service instructions.

- Check whether the kV and mAs values are clearly visible from the operator's position. Determine whether all exposure parameters are displayed correctly.

PMF "Ready" indicator

SIE Visibility of displays

SIE Correct displays

2.21 Motor drive function (MOBILETT Plus M only)

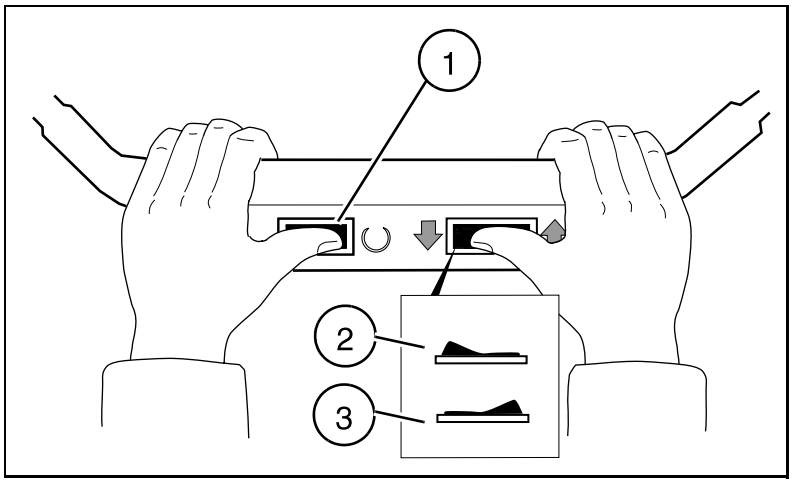

Fig. 36:

Pos. 1 Safety switch

Pos. 2 Forward

Pos. 3 Reverse

- Both switches must be activated to drive the unit.
- The drive speed must increase at a constant rate until a nominal speed of approx. 1 m/sec is reached.
- The drive is switched off if one of the two switches is released.

PMF Forward/reverse

PMF Acceleration

SIE Shutdown function

3 Changes to the previous version

Document was converted to DMS.

The hazard information was adapted to the current guidelines.